The benefits of real asset portfolio diversification

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Imagine a country that has a unique and diverse economy. Operating within this country are many well capitalised corporations. Shares in these corporations are traded on well established global exchanges. A highly liquid index of these companies also trades on a global exchange. This index has exhibited the following properties: positive returns over time; negative correlation with stocks and bonds; and excellent liquidity. In fact, such an index *does* exist, only it is not an *equity* index, but an index of *real asset prices*. It does, however, exhibit the above characteristics - all of which may provide unique benefits to financial portfolios. As institutional investors seek ways to diversify their portfolios, they are increasingly turning to commodities as an asset class. The unique characteristics of real assets warrant serious consideration by sophisticated investors.

Positive returns over time

Commodities as an asset class have historically exhibited positive returns which often equal or exceed the long term returns available from stocks and bonds. These returns are derived from several sources, including *spot returns*, *re-balancing returns*, and the *interest yield* on collateral.

Spot returns

Many commodities cost more today than they did years ago. Whether it is the cost of a house, car, or gallon of gas, we have become accustomed to a steady upward drift in prices over time. If an investor can capitalise on the upward movement in prices of real goods, the investor can help protect the value of the portfolio in real, or inflation-adjusted, terms.

Table 1 shows a snapshot of commodity prices over time. It illustrates how even though the 1990s were a period of moderate inflation, when viewed over a longer time horizon, various commodity sectors experienced strong growth in price, some even in excess of the growth in well known inflation measures such as the consumer price index.

One factor helping to drive commodity prices higher over time is ever-expanding global demand. This upward demand trend is both a function of an increasing global population and increasing industrialisation and consumption of resources per capita. For example, as populations become wealthier, they tend to drive more automobiles and consume more 'luxury' foods such as meat and cocoa. Figure 1 illustrates the steady growth in demand across a variety of commodity sectors.

Returns from re-balancing

While the general drift in spot prices accounts for a substantial portion of the returns from commodity index-linked investments, this is only part of the story. A significant portion of the returns in a commodity index that re-balances on a price percentage basis, is derived from the reallocation among the various sectors within the commodity index. This return from re-balancing is perhaps one of the least understood yet most important aspects of commodity index investing: A commodity index can increase in value over time even if the various components within the index do not increase over time.

Table 1: Commodity prices

	$$ Price 1951	$$ Price 2001	Percentage Change
Natural Gas	0.07	2.56	3407%
Crude Oil	2.53	20.11	695%
Gold	34.72	279.00	704%
Silver	0.88	4.59	421%
Wheat	2.48	2.89	17%
Corn	1.83	2.09	14%
Soyabeans	3.07	4.22	38%
Aluminium	396.83	1,354.75	241%
Copper	0.28	0.66	140%
Nickel	1,190.50	5,583.00	369%
Zinc	462.97	787.50	70%
Cattle	0.29	0.71	146%
Hogs	0.20	0.57	185%
Sugar	0.03	0.07	128%
Cotton	0.40	0.36	-12%
Cocoa	776.00	1,310.00	69%
Coffee	0.54	0.46	-15%
CPI	26.5	177.3	569%
PPI	30.9	137.6	345%

Note: 1951 prices are cash estimates derived from US Government and Industry sources; 2001 prices are based on nearby futures; rounded values shown.

Figure 1: Long term upward trends in demand

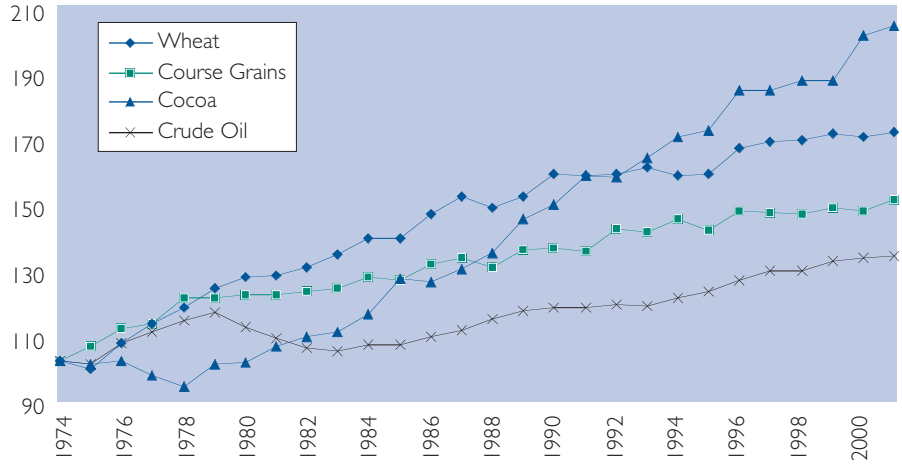


Figure 2: Commodity futures annual returns

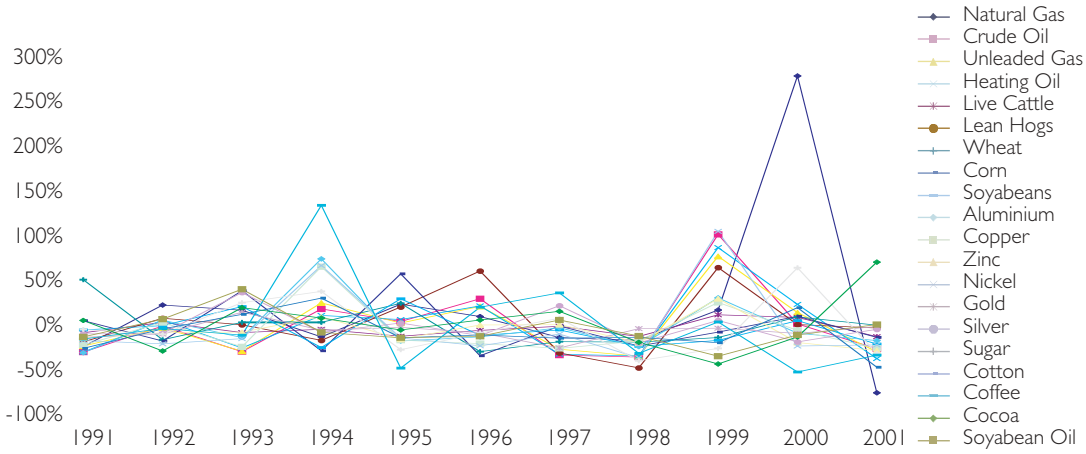
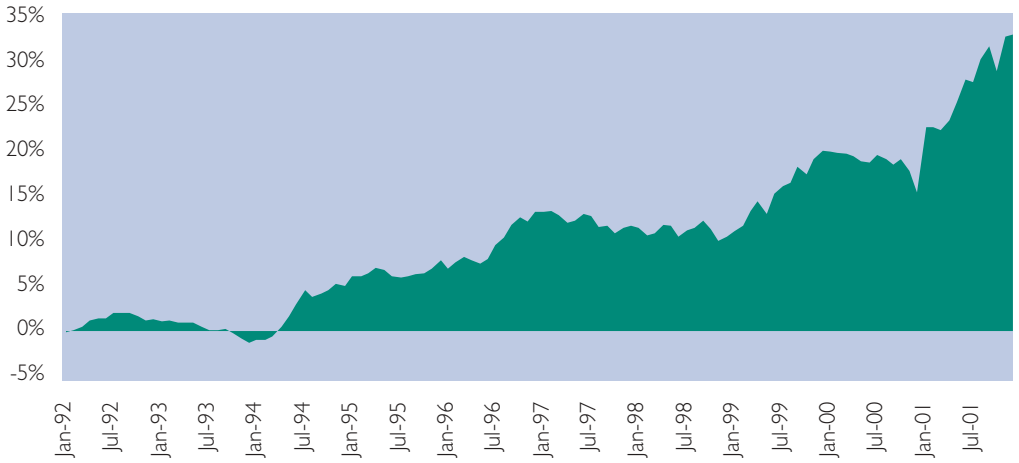


Figure 3: Rebalanced versus non-rebalanced index, cumulative outperformance



As long as the commodities in the basket do not rise and fall in perfect unison, a price re-weighted index may extract returns based on inter-market volatility and the mean-reverting tendencies of commodities markets. Figure 2 charts the annual returns of the 20 commodities in the Dow Jones – AIG Commodity Index℠ ("DJ-AIGCI℠")over the last 10 years. Of particular note is the lack of correlation and mean reverting nature of these returns, and therefore, the potential gains to be derived from price weighted re-balancing.

The positive impact of re-balancing a diversified

index such as the DJ-AIGCI can be seen by comparing the performance with that of an index which was not re-balanced. As Figure 3 illustrates, re-balancing annually improved the theoretical historical performance of the DJ-AIGCI by approximately 280 basis points per year from 1991 through 2001[1].

The historical data suggests a price re-weighted index will tend to extract returns from a basket of uncorrelated, and mean reverting commodities. One obvious question is how likely is this type of price behaviour to persist? Mean reversion in part can be explained by the 'boom and bust' tendency within the commodity markets. As prices rise, new production is brought on line. Eventually this new production causes oversupply, and prices fall. Once prices fall below a level that marginal producers consider profitable, production is trimmed, reducing supply. Prices then react to tighter supply, and the cycle is repeated.

The uncorrelated behaviour among various commodity sectors is due to the vastly different microeconomic factors that impact the various markets in a diversified commodity basket. The energy, agricultural, livestock, industrial metals, and precious metals sectors all have distinct supply and demand fundamentals, with everything from temperature levels, snowfall, automobile production, inflation expectations, and so forth impacting the sectors in very different ways.

For example, heavy winter snowfall could reduce supply shipments of cattle, increasing prices. However the snowfall may protect some crops from temperature damage, decreasing winter wheat prices. The snowfall may also result in increased hydroelectric power, reducing demand in the spring for natural gas to be used in electricity generation. As various events filter through the diverse commodity markets, their impact will tend to be felt in a variety of ways over a variety of time frames, potentially allowing continued low correlation between the commodity markets over time.

Collateral yield

Another key factor that has historically contributed to the returns from a commodity index investment is yield on collateral. A purchaser of a commodity index, unlike an equity investment, is free to invest cash[2], which can then be 'put to work' earning interest. One conservative means of estimating the magnitude of the cash returns is to assume an average three month treasury bill rate is earned. Table 2 illustrates the historical three month average treasury bill rate, compared to the dividend yield of the Dow Jones Industrial Average. As the table shows, over the last decade on average the T-Bill yield has been 211 basis points higher than the dividend yield for the DJIA. In fact, the three month treasury bill is a fairly conservative estimate of the potential returns on cash, with additional yields generally obtainable, for example from corporate money market instruments, in exchange for acceptance of non-US government credit.

The combined long term effect of spot commodity price appreciation, returns from re-balancing, and collateral yield can be estimated on an historic basis.

Table 2: Historical three month average treasury bill rate versus divided yield of the Dow Jones Industrial Average

Year	T-Bill %	Dividend	% Difference
1991	5.42	3.61	1.81
1992	3.45	3.18	0.27
1993	3.02	2.99	0.03
1994	4.29	2.80	1.49
1995	5.51	3.00	2.51
1996	5.02	2.57	2.45
1997	5.07	2.14	2.93
1998	4.81	1.90	2.91
1999	4.66	1.79	2.87
2000	5.66	1.44	4.22
2001	3.44	1.68	1.76
Average	4.58	2.46	2.11

Figure 4: Commodity basket total return 1950 - 2001, 100 Base

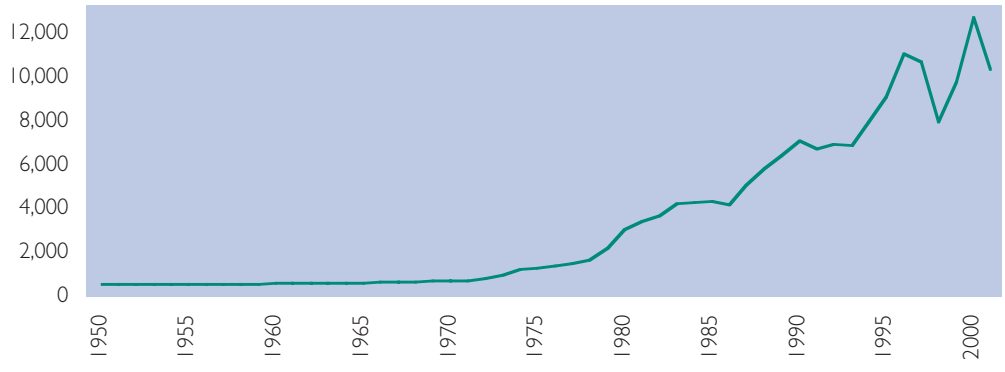


Figure 4 estimates the growth of $100 from 1950 in a basket weighted similarly to the DJ-AIGCI, re-balanced annually on a price percentage basis[3]. The 51 year annualised return is 9.5%, for a growth of $100 to over $10,000.

Negative correlations

Commodity indexes appear to be an attractive long-term investment on a stand-alone basis, with total returns comparing favourably to other asset classes such as stocks and bonds. The case for including some commodities in traditional portfolios becomes even more compelling in light of the historic negative correlation with the returns from other financial investments. A plethora of academic research[4] has verified these negative correlations and illustrated how including commodities in a diversified portfolio may favourably shift the 'efficient frontier', which represents the tradeoff between risk and reward.

The inflation link

The key to the relationship between real assets and financial assets is how they are impacted by inflation.

Table 3: Correlation of returns 1/91 – 12/01[5]

Quarterly	DJ-AIGCI vs.
S&P500	-21.4%
USTBond	-10.3%
Annually	
S&P500	-12.0%
USTBond	-18.1%

As inflation increases, the prices of financial instruments may be expected to decline. This is due to the underlying pricing mechanism of financial assets: the discounting of a stream of future cash flows ("C").

$$\text{Financial Asset} = \Sigma \left[C\, e^{-rt} \right]_i$$

In order to relate the price of commodities to the price of financial assets, we must relate the interest rate parameter 'r' to the price of commodities. Unlike financial assets, the price of commodities is determined by near term supply and demand considerations. When demand outweighs supply, prices rise, with the inverse holding true as well. If one expects the supply/demand situation to tighten in the future, a decision to buy and hold this commodity may be taken, assuming financing of the position at 'r', with the hope of selling at a profit in the future. Therefore, as investors project higher commodity prices in the future, i.e. raw material price inflation, we would expect them to be willing to pay higher interest rates as they compare their expected returns with the current financing rates available in the market.

As a result we would expect to see a positive relationship between the price behaviour of an index such as the DJ-AIGCI, and the path of interest rates. As one example, we can compare a chart of the DJ-AIGCI and three month treasury bill rates (Figure 5).

Similarly we would expect to see a positive relationship between commodities prices and more traditional inflation measures such as the producer price index (Figure 6).

Implementation

Diversification within the commodity index allocation

Once there is acceptance of the efficacy of adding exposure to a commodity index within a traditional financial portfolio, there is still the question of implementation of this commodity exposure itself. One key issue to address is whether it is better to gain exposure using a broad commodity market exposure or through a more narrow investment in one or more commodity sectors. Prudent investors will generally diversify their exposure within any asset class. The case for diversification is premised on several axioms:

1. Individual asset class components may be unduly subjected to micro-economic supply/demand

Figure 5: DJ-AIGCI versus 3 month treasury bill

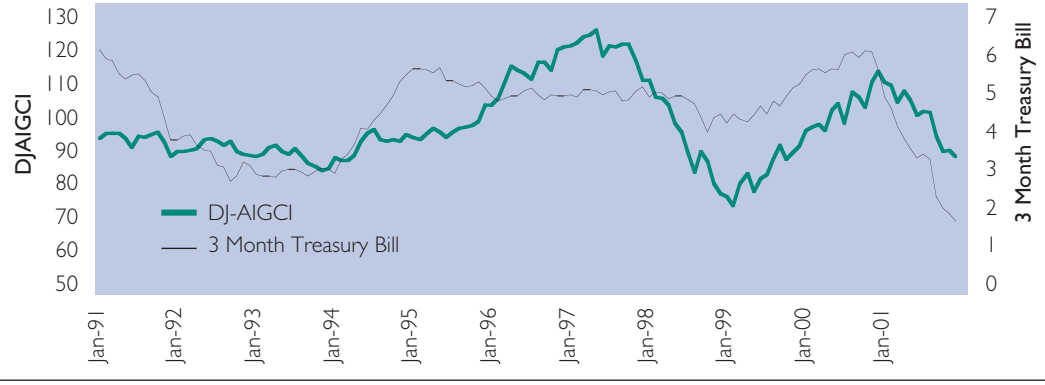
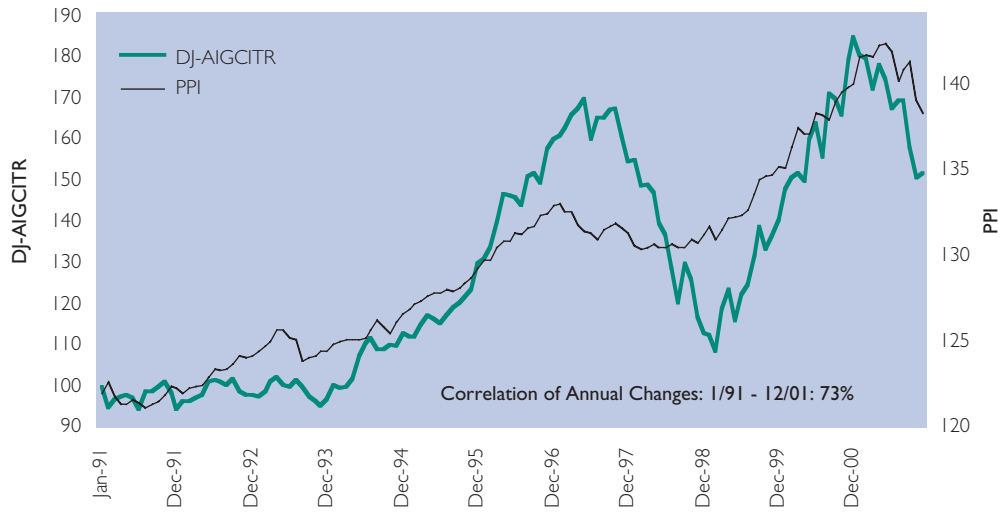


Figure 6: DJ-AIGCI total return index vs. PPI

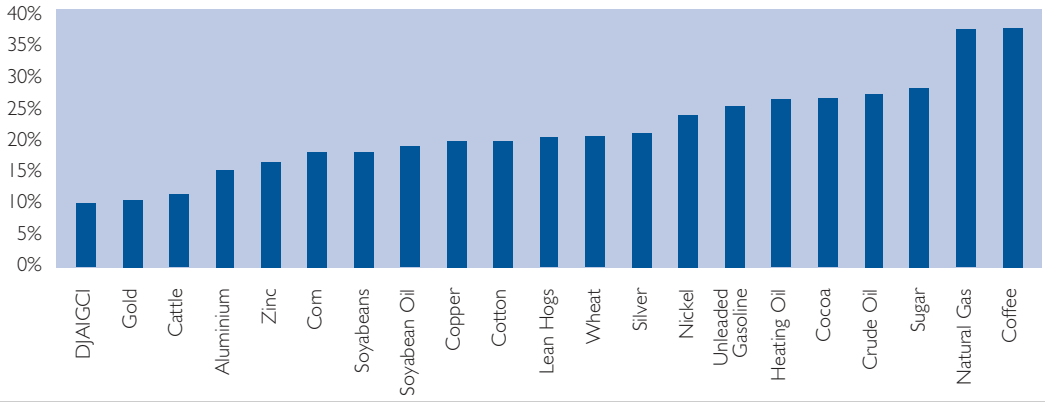


shocks. Excessive exposure to such events within a particular equity, bond or commodity may overwhelm the desirable intrinsic properties of the asset class. For example, an investor may decide that equity exposure should play a key role in a portfolio due to a study of long term asset class returns, then find that concentrated exposure to a particular company or industry can lead to sub-optimal performance. Figure 7 illustrates how exposure to a broadly diversified index such as the DJ-AIGCI may provide a standard deviation of returns below that of even the least volatile component within the index itself.

2. The predictive value of historical returns for an individual asset class component may not be as robust as that of a large collection of asset class components. It is more likely that the behaviour of an individual stock, bond or commodity may change more dramatically and unexpectedly over time than will the behaviour of an entire diversified asset class.
3. The returns available from an asset class are typically a function of both the shared properties that define the asset class (how all members of the asset class are impacted by broad macro-economic trends), and by the unique gains to be obtained over time from various sectors and individual asset class members. Exposure to a broad array of commodities may optimise the potential for smooth and steady returns from different segments of the asset class.
4. Real world implementation issues such as liquidity and market inefficiencies often favour diversified exposure within asset classes.

To illustrate the benefits of diversification as it relates to liquidity, in an implementation of a commodity index allocation, we can compare the exposure within each component of the DJ-AIGCI, given a $100m allocation, to the volume and open interest within each market. Figure 8 highlights that even a substantial allocation such as $100,000,000 would represent less than 1:20th of the sample volume, and less then 1:200th of the open interest for each component. This would suggest that any

Figure 7: Average 20 day historical futures volatilities, 1991-2001



'footprint' to be felt by implementing a position is likely to be lessened as this exposure is spread more evenly through the asset class. It is important to note that the scale on Figure 8 runs from 0% to 4%. If the full scale, i.e. up to 100%, were shown, the volume and open interest bars would be barely visible.

The impact of diversification on correlation

Commodities, like other asset classes, share certain common features in terms of their expected behaviour under various macro-economic conditions. As discussed above, a key link between commodity prices and financial asset prices is inflation, which can result from several root causes, including:

- excessive monetary liquidity;
- macro demand-driven price appreciation; and
- supply/demand imbalances in individual markets.

All of these factors will impact commodity prices, but will vary in their influence upon individual commodity sectors over time. For example, 'industrial' commodities, such as base metals, energy and cotton will tend to be especially sensitive to the level of overall global economic activity. Alternatively, many agricultural commodities will tend to respond to supply/demand fundamentals (e.g. weather events, shifting global consumption patterns.) Other commodities, such as gold, tend to be heavily influenced by perceived levels of global monetary stability and liquidity.

Although various commodity sectors will respond uniquely to different inflationary pressures, the asset class in the aggregate has historically provided robust negative correlation with stocks and bonds. Diversified exposure across the asset class may yield superior longer term correlation properties, compared to individual commodity sectors.

To test this hypothesis, we consider the performance of the Dow Jones – AIG Commodity Index, which provides broadly diversified exposure to the asset class, against the performance of its component subindexes[6] (Table 4).

As expected, the tendency of the overall asset class to exhibit negative correlation with stocks and bonds, and positive correlation with inflation, often tends to exceed that of any individual sub-index over the time series.

A further expected benefit of diversification can be demonstrated by analysing how correlation data changes over time. In Table 5 we compare the behaviour of the DJ-AIGCI with the DJ-AIG energy sub-index over a series of five year windows beginning in January 1991 through December 2001 measured at quarterly intervals[7]. In addition, we compare the correlation of the S&P and bonds with the CRB[8].

Not only does the DJ-AIGCI demonstrate robust

Figure 8: $100m investment in the DJ-AIGCI, percent of total open interest and daily volume (As of 6/28/01)

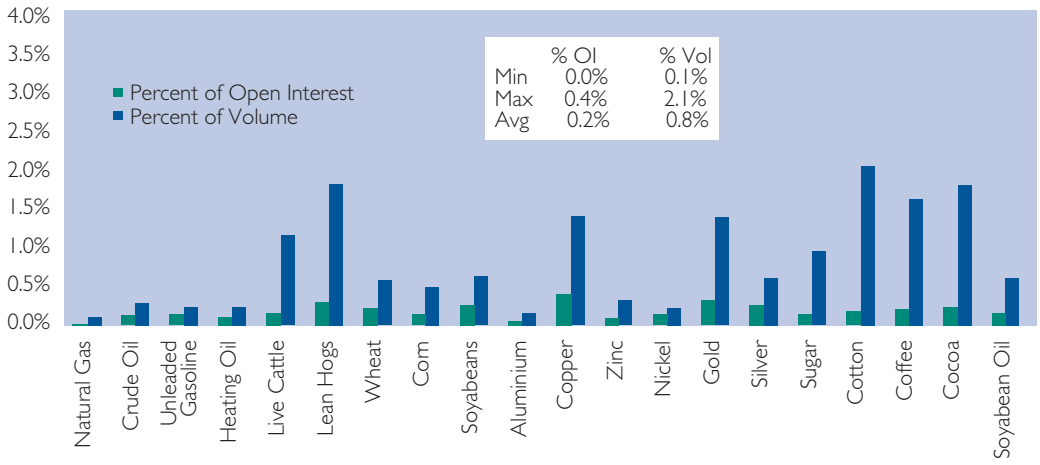


Table 4: Factor correlations 1991 – 2001

	S&P 500	Lehman Bond	Unexpected Inflation
DJ-AIGCI Composite	-21%	-17%	44%
DJ-AIGCI Energy	-25%	-3%	47%
DJ-AIGCI Petroleum	-24%	-11%	53%
DJ-AIGCI Live Stock	-3%	1%	21%
DJ-AIGCI Grains	10%	3%	2%
DJ-AIGCI Industrial Metals	-1%	-44%	10%
DJ-AIGCI Precious Metals	-25%	-13%	11%
DJ-AIGCI Softs	18%	-29%	-3%

Table 5: Correlation of quarterly returns, rolling 5 year windows, (January 1991 – December 2001)

	S&P 500vs.				Bonds vs.		
	DJ-AIGCI	DJ-AIG Energy	CRB		**DJ-AIGCI**	DJ-AIG Energy	CRB
Average	-24.8%	-18.1%	-11.4%	Average	-23.5%	-6.7%	-27.2%
Stdev	12.8%	18.7%	12.5%	Stdev	9.0%	8.0%	8.6%
Ratio	1.94	0.97	0.91	Ratio	2.62	0.84	3.18

negative correlation over time, but the 'performance ratio' (defined as the ratio of the average correlation absolute value to the standard deviation of the observed correlations) is in general sharply higher for the diversified DJ-AIGCI. This may stem from the fact that over time, different sectors of the commodity spectrum will experience price volatility which in turn may be related to financial asset behaviour. By maintaining broad commodity market exposure and including significant weightings of key sectors such as industrial and precious metals, grains, livestock, and soft commodities, the diversified DJ-AIGCI may tend to reflect the pertinent 'price shocks' at any given time, rather than depend on one sector to provide all the diversification benefits.

The impact of diversification on Sharpe Ratios

Another means of evaluating the benefits of a portfolio allocation utilising diversified commodity exposure is to consider the impact of such an allocation on the Sharpe Ratio of the portfolio[9]. In Table 6 we compare a series of five year periods, evaluated quarterly, beginning in January 1991 through December 2001, in which alternatively the DJ-AIGCI, the DJ-AIG energy sub-index, or the CRB is included in a 10% allocation to a portfolio of 55% stocks and 35% bonds. We compare the performance of this portfolio to one consisting of 60% stocks and 40% bonds[10] .

Table 6: Improvement to portfolio sharpe ratio, quarterly observations rolling 5 year periods (January 1991 – December 2001)

	DJ-AIGCI	DJ-AIG Energy	CRB
Average	8.7%	17.0%	2.4%
Stdev	5.7%	17.8%	5.1%
Ratio	1.53	0.96	0.46
Risk Adjusted Average	**8.7%**	**5.5%**	**2.6%**

Table 6 indicates that the DJ-AIGCI provided the largest improvement to the Sharpe Ratio on a risk adjusted basis, where the variability of the improvement over time is taken into account. Although the DJ-AIG Energy Sub-index provided the largest absolute increase to the portfolio Sharpe Ratio, on average the *variability* of this improvement from one period to the next was sharply higher than that of the diversified DJ-AIGCI. Adjusting the average improvement by the ratio of the standard deviation, termed the 'risk adjusted average' in Table 6, we see that the DJ-AIGCI exposure provided approximately double the historical Sharpe Ratio improvement compared to the other indexes.

In sum, the diversified DJ-AIGCI tended to provide in the historical simulation the most stable improvement to the sample portfolio Sharpe Ratio. Although a narrow sector focus, using for example the DJ-AIG Energy Sub-index, could at times provide a larger increase to portfolio returns, this would depend largely on successful market timing. As a long term allocation implemented to diversify a financial portfolio, the stability of the benefits of the diversified DJ-AIGCI would suggest this may be a preferable choice.

Conclusion

Recent events have helped dispel the myth that stocks can only go up, and that commodities are a risky bet best left to the experts in the trading pits. Sophisticated investors are increasingly adopting the view that including broad exposure to the commodity markets through an index such as the DJ-AIGCI may actually be a *prudent* move. Such an inclusion may lower the overall volatility of the portfolio, and may provide positive returns over time on a stand-alone basis as well.

The principal benefits which historically have been derived from diversified commodity exposure include:

- **long term positive returns;**
- **robust overall negative correlations with stocks and bonds; and**
- **generally reliable increases to the Sharpe Ratio.**

AIGCI Handbook. DJ-AIGCI and commodity basket historical returns prior to 1998 were calculated based on the 1998-1999 percentage weights, with commodity basket weights and calculations adjusted for data availability. Nothing contained herein should be construed as a solicitation to enter into any transaction. AIGI does not act as a fiduciary or financial, investment or commodities trading advisor for its counterparties, each of which is responsible for its own investment and trading decisions. Past performance does not guarantee future results. Dow Jones is a service mark of Dow Jones & Company. Dow Jones does not sponsor, promote, or sell any product based on the Dow Jones-AIG Commodity Index and AIGI and Dow Jones make no representation herein regarding the advisability of investing in any product based on the Index.

Notes:

1 Non-Rebalanced Index using 1991 DJ-AIGCI unit weights. Return differential from Dec 31, 1991 through Dec 31 2001.

2 A percentage of the total notional investment must be posted as margin with the exchange, however this cash generally bears interest.

3 This estimate does not factor in the effects of roll yield. Prior to 1991 commodity basket returns are estimates based on available cash market data and the approximate DJ-AIGCI weights as of Jan 1991.

4 See, e.g., Ankrim, E. and Hensel, C., Commodities in Asset Allocation: A Real-Asset Alternative to Real Estate, Financial Analysts Journal (May/June 1993), 20-29; Froot, K., Hedging Portfolios with Real Assets, Journal of Portfolio Management (Summer 1995), 60-77; Huberman, G., The Desirability of Investment in Commodities via Commodity Futures, Derivatives Quarterly (Fall 1995), 65-67; Georgiev, G., "Benefits of Commodity Investment", CISDM Working Paper (June 2001).

5 Correlation of Total Return Indexes. US Treasury Bond returns calculated using the Lehman Brothers Long Treasury Bond Index.

6 Table from the working paper by Georgi Georgiev, "Benefits of Commodity Investment", CISDM Working Paper, June 2001, Updated December 2001. Correlations of quarterly returns. Lehman Bond as referred to in this table is the Lehman Brothers Aggregate Bond Index. The Lehman Brothers Aggregate Bond Index is a trademark of Lehman Brothers, Inc.

7 Quarterly total returns for the DJ-AIGCI, DJ-AIG Energy, S&P500, Lehman Brothers Long Treasury Bond Index, and CRB. The S&P 500 is a trademark of Standard & Poor's, a division of The McGraw Hill Companies, Inc. The Lehman Brothers Long Treasury Bond Index is a trademark of Lehman Brothers, Inc.

8 CRB return calculations include collateral yield using a weekly rolling 3 month Treasury Bill rate. CRB is a trademark of Bridge/Commodity Research Bureau.

9 Theoretical portfolio values calculated on a quarterly basis, using total returns for the DJ-AIGCI, DJ-AIG Energy, S&P500 ("Stocks"), Lehman Brothers Long Treasury Bond Index ("Bonds"), and CRB.

10 For purposes of the chart, Improvement to Portfolio Sharpe Ratio calculated as portfolio Sharpe Ratio including commodities minus Sharpe Ratio of portfolio without commodities. The Risk Adjusted Average for the DJ-AIG Energy and the CRB is calculated as {Average x StdevDJ-AIGCI / Stdev}.

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